ISSN 0704-3716

Canadian Translation of Fisheries and Aquatic Sciences

No. 5330

Recent data on the effects of freeze drying: Effects on residues of pesticides and polychlorinated biphenyls

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Original title: Recenti acquisizioni sugli effetti della liofilizzazione: conseguenze sui residui di antiparassitari e di policlorobifenili

Published by: Il Freddo 30 (5-6): 265-268, 1976

Original language: Italian

Available from:
Canada Institute for Scientific and Technical Information
National Research Council
Ottawa, Ontario, Canada K1A 0S2

1987

7 typescript pages

	DFO	IPB	Ottawa
2909957	Italian	LLH	30 March 1987

RECENT DATA ON THE EFFECTS OF FREEZE-DRYING:
EFFECTS ON RESIDUES OF PESTICIDES AND POLYCHLORINATED BIPHENYLS

Freeze-drying, a more modern and practical version of dehydration, has in the space of a few short years gone from being an experimental technique to a fully operational industrial technology. It has proven to be a sophisticated and efficient technology in many important sectors of industrial production. Freeze-drying makes it possible to store even the most delicate products virtually indefinitely, without altering their composition or integrity and at the same time permitting easy reconstitution for consumption.

If it were not for the still high cost of freeze-drying, it would have already supplanted all the other techniques used in industry for removing moisture: roller drying, spray drying, foam drying, counter-current drying - all processes which use heat. In fact,

freeze-drying has virtually none of the drawbacks of these technologies, which are however useful in many cases, and above all, have much lower costs.

Today the most important applications of freeze-drying include preparation of pharmaceuticals which are unstable in solution and of foods of high intrinsic unit value, such as instant coffee, homogenized fruits and meat, and vegetables for soup mixes.

Food dehydrated using this technology is effectively protected against many forms of spoilage, such as rancidity, darkening, which can make food less palatable and affect its biological value, and microbiological processes, such as the action of yeasts and moulds which can also cause the formation of toxic substances.

Freeze-drying enables the product to be transported anywhere and stored virtually indefinitely.

It cannot be overemphasized that freeze-drying of food does not involve the use of "voluntary" additives, such as anti-oxidants, anti-microbial agents, anti-biotics, gelling agents or thickeners, and that the freeze-drying process also reduces levels of contamination by "involuntary" additives, that is to say, those toxic chemical compounds, such as pesticides, which are indispensable for protecting agricultural and livestock production.

RECENT FINDINGS

Recent research has repeatedly demonstrated that this technique, which is based on a combination of deep freezing and high vacuum, has an additional advantage of great significance to the food processing sector. In fact, as a number of authors have pointed out, freeze-drying does not simply remove water without damaging the composition and molecular structure and therefore the nutritional value of foods; it also, to a varying but always considerable extent, removes residues of organic chloride insecticides, such as DDT, lindane, endrin, dieldrin, heptachlor, heptachlorepoxide, aldrin and chlordane, as well as residues of polychlorinated biphenyls, compounds which are extremely useful and have a wide range of applications, but which are also exceptionally toxic.

The result is more wholesome foods.

Zabik and Dugan[1] studied whole eggs and egg yolks, and found that in whole eggs the freeze-drying process caused a substantial decrease in contamination by organic chloride pesticides; in fact, residues of lindane were reduced by 79%, dieldrin by 37% and DDT by 44%. What we are witnessing is in fact large-scale decontamination, which has also been observed, although to a somewhat lesser degree, with freeze-dried egg yolks. Presumably, the original fat content of the food, the physical characteristics of each compound, for example vapour pressure, and the extent of initial contamination all influence the extent to which pesticide residues are removed.

Johnson et al[2] studied tobacco and noted that even in this case freeze-drying causes a substantial reduction in the concentration of various residues: TDE is reduced by 42%, DDT by 41% and endosulfan by 43%.

Cerutti et al[3] examined the effects of freeze-drying on fresh milk, cream, whey and curd, demonstrating, as is shown in diagrams 1, 2, 3 and 4, that this technological process reduces the overall level of contamination by organic chloride pesticide residues to a variable extent depending on the product: hence a moderate reduction was observed in cream, similar to the results reported by Zubik and Dugan for egg yolk, while a considerable or very considerable reduction was observed in milk, whey and curd. For milk the reduction was in the order of 85%, for whey 95-96% and for curd 50%. The lower the fat content of the material to be freeze-dried, the easier it is to remove residues. The reduction in residues was observed for all the pesticides studied: lindane and its isomers, DDT and its transformation products, heptachlor and heptachlorepoxide, aldrin and dieldrin.

Even more recently, Khan et at[4] studied the fate of the other family of highly toxic organic chloride pollutants: the PCBs or polychlorinated biphenyls.

As is known, PCBs are not only highly toxic, they are also exceptionally resistent to biodegradation[5], hence the need to develop stringent control measures and to look for less toxic substitutes. The analogous PBBs (polybromobiphenyls) have been proposed as substitutes, as has butylmonochlorobyphenyloxide[6]. PCBs have been used in areas such as synthetic rubber, paints, plastics, insulation and printers' inks. They are also being used[7] as heat exchanging fluids, hydraulic fluids, combustion retardants and stabilizers in pesticides, thereby

contaminating the entire ecosystem, that is to say water, air, land and foods. The risk is so great[7] that even PCB manufacturers have restricted their use to specific applications. The US Department of Agriculture has restricted its use, excluding it, for example, from pesticide formulations in which it was used to prolong effectiveness by lowering vapour pressure, in certain cases increasing pesticide toxicity by synergism.

It has also been noted that PCBs are destroyed by heat only above 950^0. From this it may easily be deduced that PCBs can contaminate the atmosphere when materials containing them are burned at normal temperatures, below 950^0. In any case, the experiments of Khan et al have demonstrated that freeze-dried shrimp and eggs contain 25-40% less of certain PCBs than the fresh product, findings similar to those made with organic chloride pesticide residues.

These few examples demonstrate that freeze-drying may well be considered not only a worthwhile technology in terms of product integrity, storage and reconstitution, but also an effective decontamination method for toxic residues such as organic chloride pesticides and polychlorinated byphenyls.

BIBLIOGRAPHY

(1) E. M. Zabik, L. R. Dugan Jr. - Potential of freeze-drying for removal of hydrocarbon insecticides from eggs. - JOURNAL OF FOOD SCIENCE. 36, 87, 1971.

(2) W. H. Johnson, J. J. Domanski, T. J. Sheets, C. S. Chang - Effects of freeze-drying on residues of TDE, DDT and endo-sulfan in tobacco - JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY, 23, 117, 1975.

(3) G. Cerutti, R. Zappavigna, A. Gerosa - Residui di antiparassitari cloro- e fosfoorganici in latte e derivati [Residues of chloro- and phospho-organic pesticides in milk and milk derivatives] - IL LATTE, 3, 161, 1975.

(4) M. A. Khan, M. R. Rao, A. R. Novak - Reduction of polychlorinated biphenyls in shrimps and eggs by freeze-drying techniques - JOURNAL OF FOOD SCIENCE, 41, 1137, 1976.

(5) XXX - Living with polychlorinated biphenyls - FOOD AND COSMETICS TOXICOLOGY, 13, 574, 1975.

(6) Chemical and Engineering NEWS, 8 dic. 1975, p 7

(7) C. Vannucchi, G. Ghimenti, R. Canesi, G. Taponeco - Determinazione dei residui di pesticidi e di PCB negli alimenti [Determination of pesticide and PCB residues in foods] - RIV. SOCIETA ITALIANA SCIENZA ALIMENTAZIONE, 2, 71, 1973.